WHAT IS CLAIMED IS:

1. A coaxial starter motor assembly comprising:

a housing;

an electrical motor provided in the housing having a rotatable armature shaft;

a rotatable drive shaft engageably linked with the armature shaft;

a pinion assembly provided in the housing engageable at one end with the drive shaft and including a pinion at the other end engageable with a flywheel of an engine;

a solenoid assembly provided in the housing for selectively energizing the electrical motor, wherein the solenoid assembly is coaxial with the drive shaft, the solenoid assembly including a plunger having a bore, the plunger being engageable with the pinion assembly to move the pinion assembly including the pinion into engagement with the flywheel, and the plunger being engageable with a moveable contact to move the moveable contact to electrically connect with a pair of fixed contacts;

a return spring positioned at least in part within the bore of the plunger of the solenoid assembly for moving the pinion assembly including the pinion away from engagement with the flywheel, wherein the return spring is spaced from the pinion assembly;

wherein energization of the solenoid assembly moves the plunger to move the pinion assembly to engage the pinion with the flywheel;

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wherein upon deenergization of the solenoid assembly, the return spring moves the pinion assembly to move the pinion from engagement with the flywheel; and

wherein upon deenergization of the solenoid assembly, the plunger is capable of moving independently of the pinion assembly to thereby break the electrical connection between the moveable contact and the fixed contacts before the return spring moves the pinion assembly to move the pinion away from engagement with the flywheel.

2. The coaxial starter motor assembly of claim 1, wherein the plunger is capable of moving independently of the pinion assembly to thereby break the electrical connection between the moveable contact and the fixed contacts while the pinion is in engagement with the flywheel.

3. The coaxial starter motor assembly of claim 1, wherein the plunger is capable of moving independently of the pinion assembly to prevent run-on of the electrical motor if the engine fails to start upon engagement of the pinion and the flywheel.

4. The coaxial starter motor assembly of claim 1, further comprising a contact member, the contact member engaging the plunger and engaging the pinion assembly so that movement of the plunger moves the pinion assembly, the contact member being positioned within the bore of the plunger and contacting a contact surface of the plunger, the contact member further being positioned within a groove

formed around an external surface of the pinion assembly;

wherein a first end of the return spring pushes against the contact member; and

wherein upon deenergization of the solenoid assembly, the return spring moves the contact member which in turn moves the pinion assembly to move the pinion from engagement with the flywheel.

5. A coaxial starter motor assembly comprising:

a housing;

an electrical motor provided in the housing having a rotatable armature shaft;

a rotatable drive shaft engageably linked to the armature shaft;

a pinion assembly provided in the housing, the pinion assembly including a pinion shaft, the pinion shaft engageable at one end with the drive shaft and including a pinion at the other end engageable with a flywheel of an engine, and the pinion shaft including a groove formed around an external surface of the pinion shaft;

a solenoid assembly provided in the housing for selectively energizing the electrical motor, wherein the solenoid assembly is coaxial with the drive shaft, the solenoid assembly including a plunger having a bore, the plunger being engageable with the pinion shaft to move the pinion into engagement with the flywheel and the plunger being engageable with a moveable contact to move the moveable contact to electrically connect with a pair of fixed contacts;

a return spring positioned around the pinion shaft without contacting the

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pinion shaft, the return spring being positioned at least in part within the bore of the plunger of the solenoid assembly; and

a contact member positioned within the groove formed around the external surface of the pinion shaft, the contact member also being positioned within the bore of the plunger of the solenoid assembly;

wherein energization of the solenoid assembly moves the plunger which in turn moves the contact member which in turn moves the pinion shaft to thereby engage the pinion with the flywheel;

wherein upon deenergization of the solenoid assembly, the return spring moves the contact member which in turn moves the pinion shaft to move the pinion from engagement with the flywheel; and

wherein upon deenergization of the solenoid assembly, the plunger is capable of moving independently of the pinion shaft to thereby break the electrical connection between the moveable contact and the fixed contacts before the return spring moves the contact member to move the pinion shaft to move the pinion away from engagement with the flywheel.

6. The coaxial starter motor assembly of claim 5, wherein the plunger is capable of moving independently of the pinion shaft to thereby break the electrical connection between the moveable contact and the fixed contacts while the pinion is in engagement with the flywheel.

7. The coaxial starter motor assembly of claim 5, wherein the plunger is capable of moving independently of the pinion shaft to prevent run-on of the electrical motor if the engine fails to start upon engagement of the pinion and the flywheel.

8. The coaxial starter motor assembly of claim 5, further comprising a plunger stop assembly provided around the pinion assembly, wherein the plunger seats against the plunger stop assembly when the plunger has moved from a rest position to its farthest axial position toward engagement of the pinion and the flywheel.

9. The coaxial starter motor assembly of claim 8, wherein D, a maximum distance that the pinion shaft may travel from a rest position when moving in an axial direction toward engagement of the pinion and the flywheel, is determined;

wherein G, a distance that the plunger may still move in the axial direction toward engagement of the pinion and the flywheel after the moveable contact electrically connects with the pair of fixed contacts, is determined;

wherein H, a minimum distance between an internal spline stop of the pinion shaft and an external spline axial stop on the drive shaft, is determined, wherein the distance H is equal to a distance that the pinion shaft may still travel after the plunger seats against the plunger stop assembly;

wherein K, a minimum distance to open the moveable contact from the fixed contacts to thereby break the electrical connection between the moveable contact and the fixed contacts when the pinion shaft is positioned in its farthest axial position toward engagement of the pinion and the flywheel, is determined;

wherein the following three equations are solved to determine distances A, B, and C, wherein A is a maximum distance that the plunger may move independent of the pinion shaft relative to the pinion shaft, B is a maximum distance between the moveable contact and the fixed contacts, and C is the maximum distance that the plunger may travel from a rest position when moving in the axial direction toward engagement of the pinion and the flywheel:

(1) $B = K + D$,

(2) $C = G + B$, and

(3) $A = H - D + C$.

10. The coaxial starter motor assembly of claim 9, wherein the distance G is the minimum distance that a contact overtravel spring may be compressed.

11. A method of operating a coaxial starter motor assembly that includes a housing; an electrical motor provided in the housing having a rotatable armature shaft; a rotatable drive shaft engageably linked with the armature shaft; a pinion assembly provided in the housing engageable at one end with the drive shaft and including a pinion at the other end engageable with a flywheel of an engine; a solenoid assembly provided in the housing for selectively energizing the electrical motor, wherein the solenoid assembly is coaxial with the drive shaft, the solenoid assembly including a plunger having a bore, the plunger being engageable with the pinion assembly to move the pinion assembly including the pinion into engagement with the flywheel, and the plunger being engageable with a moveable contact to move the moveable contact to

electrically connect with a pair of fixed contacts; a return spring positioned at least in part within the bore of the plunger of the solenoid assembly for moving the pinion assembly including the pinion away from engagement with the flywheel, wherein the return spring is spaced from the pinion assembly; wherein energization of the solenoid assembly moves the plunger to move the pinion assembly to engage the pinion with the flywheel; and wherein upon deenergization of the solenoid assembly, the return spring moves the pinion assembly to move the pinion from engagement with the flywheel;

the method comprising the step of:

moving the plunger independently of the pinion assembly upon deenergization of the solenoid assembly to thereby break the electrical connection between the moveable contact and the fixed contacts before the return spring moves the pinion assembly to move the pinion away from engagement with the flywheel if the engine fails to start upon engagement of the pinion and the flywheel.

12. The method of operating a coaxial starter motor assembly of claim 11, wherein the step of moving the plunger independently of the pinion assembly to thereby break the electrical connection between the moveable contact and the fixed contacts occurs while the pinion is in engagement with the flywheel.

13. A method of operating a coaxial starter motor assembly including a housing; an electrical motor provided in the housing having a rotatable armature shaft; a rotatable drive shaft engageably linked to the armature shaft; a pinion assembly provided in the housing, the pinion assembly including a pinion shaft, the pinion shaft

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engageable at one end with the drive shaft and including a pinion at the other end engageable with a flywheel of an engine, and the pinion shaft including a groove formed around an external surface of the pinion shaft; a solenoid assembly provided in the housing for selectively energizing the electrical motor, wherein the solenoid assembly is coaxial with the drive shaft, the solenoid assembly including a plunger having a bore, the plunger being engageable with the pinion shaft to move the pinion into engagement with the flywheel and the plunger being engageable with a moveable contact to move the moveable contact to electrically connect with a pair of fixed contacts; a return spring positioned around the pinion shaft without contacting the pinion shaft, the return spring being positioned at least in part within the bore of the plunger of the solenoid assembly; and a contact member positioned within the groove formed around the external surface of the pinion shaft, the contact member also being positioned within the bore of the plunger of the solenoid assembly; wherein energization of the solenoid assembly moves the plunger which in turn moves the contact member which in turn moves the pinion shaft to thereby engage the pinion with the flywheel; and wherein upon deenergization of the solenoid assembly, the return spring moves the contact member which in turn moves the pinion shaft to move the pinion from engagement with the flywheel;

the method comprising the step of:

moving the plunger independently of the pinion shaft upon deenergization of the solenoid assembly to thereby break the electrical connection between the moveable contact and the fixed contacts before the return spring moves the contact member to move the pinion shaft to move the pinion away from engagement with the flywheel if the engine fails to start upon engagement of the pinion and the flywheel.

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14. The method of operating a coaxial starter motor assembly of claim 13, wherein the step of moving the plunger independently of the pinion shaft to thereby break the electrical connection between the moveable contact and the fixed contacts occurs while the pinion is in engagement with the flywheel.

15. A method of designing a coaxial starter motor assembly, the coaxial starter motor assembly including a housing; an electrical motor provided in the housing having a rotatable armature shaft; a rotatable drive shaft engageably linked to the armature shaft; a pinion assembly provided in the housing, the pinion assembly including a pinion shaft, the pinion shaft engageable at one end with the drive shaft and including a pinion at the other end engageable with a flywheel of an engine, and the pinion shaft including a groove formed around an external surface of the pinion shaft; a solenoid assembly provided in the housing for selectively energizing the electrical motor, wherein the solenoid assembly is coaxial with the drive shaft, the solenoid assembly including a plunger having a bore, the plunger being engageable with the pinion shaft to move the pinion into engagement with the flywheel and the plunger being engageable with a moveable contact to move the moveable contact to electrically connect with a pair of fixed contacts; a return spring positioned around the pinion shaft without contacting the pinion shaft, the return spring being positioned at least in part within the bore of the plunger of the solenoid assembly; a contact member positioned within the groove formed around the external surface of the pinion shaft, the contact member also being positioned within the bore of the plunger of the solenoid assembly; and a plunger stop assembly provided around the pinion assembly, wherein the plunger

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seats against the plunger stop assembly when the plunger has moved from a rest position to its farthest axial position toward engagement of the pinion and the flywheel; wherein energization of the solenoid assembly moves the plunger which in turn moves the contact member which in turn moves the pinion shaft to thereby engage the pinion with the flywheel; wherein upon deenergization of the solenoid assembly, the return spring moves the contact member which in turn moves the pinion shaft to move the pinion from engagement with the flywheel; and wherein upon deenergization of the solenoid assembly, the plunger is capable of moving independently of the pinion shaft to thereby break the electrical connection between the moveable contact and the fixed contacts before the return spring moves the contact member to move the pinion shaft to move the pinion away from engagement with the flywheel,

the method comprising the steps of:

determining D, a maximum distance that the pinion shaft may travel from a rest position when moving in an axial direction toward engagement of the pinion and the flywheel;

determining G, a distance that the plunger may still move in the axial direction toward engagement of the pinion and the flywheel after the moveable contact electrically connects with the pair of fixed contacts;

determining H, a minimum distance between an internal spline stop of the pinion shaft and an external spline axial stop on the drive shaft, wherein the distance H is equal to a distance that the pinion shaft may still travel after the plunger seats against the plunger stop assembly;

determining K, a minimum distance to open the moveable contact from the

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fixed contacts to thereby break the electrical connection between the moveable contact and the fixed contacts when the pinion shaft is positioned in its farthest axial position toward engagement of the pinion and the flywheel; and

45 solving the following three equations to determine distances A, B, and C, wherein A is a maximum distance that the plunger may move independent of the pinion shaft relative to the pinion shaft, B is a maximum distance between the moveable contact and the fixed contacts, and C is the maximum distance that the plunger may travel from a rest position when moving in the axial direction toward engagement of the

50 pinion and the flywheel:

(1) $B = K + D$,

(2) $C = G + B$, and

(3) $A = H - D + C$.

16. The method of designing a coaxial starter motor assembly of claim 15, wherein the distance G is the minimum distance that a contact overtravel spring may be compressed.